DEPARTMENT OF NATIONAL DEFENCE
CANADA

OPERATIONAL RESEARCH DIVISION

DIRECTORATE OF OPERATIONAL RESEARCH (JOINT & LAND)

DOR(J&L) RESEARCH NOTE RN 9811

QUARRÉ DE FER
ACV-WAR
(LAV IN WARFIGHTING TASKS)

BY

P. Bender
M.K. Ormrod

MAY 1998

OTTAWA, CANADA

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ABSTRACT

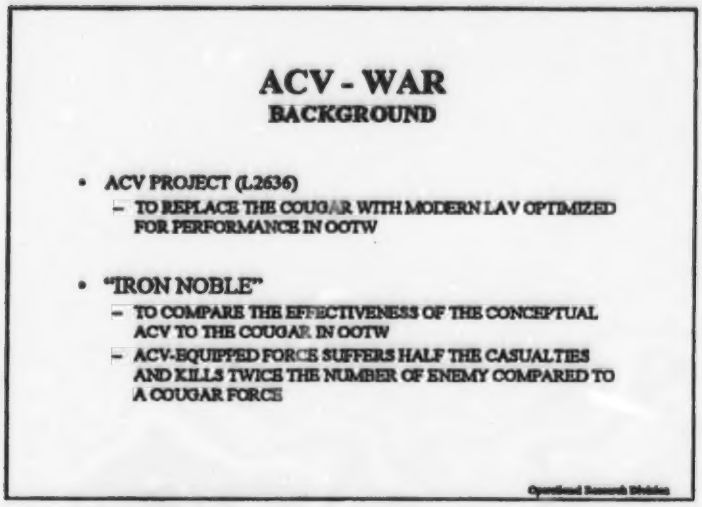
To meet the direct fire support requirements within the medium and high levels of conflict, the Canadian Land Forces are considering a Light Armoured Vehicle (LAV) as a replacement for its Leopard C1 Main Battle Tank (MBT).

This briefing presents the analysis results of the JANUS wargaming that was conducted in order to determine the effectiveness of the LAV with a 105mm gun in comparison with a modern MBT in warfighting tasks. The results were presented at the 24 QWG AOR Meeting 24-31 March 1998, Adelaide, Australia.

LAV IN WARFIGHTING TASKS
ACV-WAR

Mr. P. Bender
Mr. M. Ormrod
Operational Research Division
National Defence Headquarters
Ottawa, Canada

This afternoon I would like to present to you the results of our latest Research War Game series "QUARRÉ DE FER" aimed at examining the effectiveness of a light armoured vehicle in warfighting tasks. This work has been conducted under the designation of the "ACV-WAR" project. I will give you an overview of the background leading to this project, followed by a quick look at the scenario to focus then on the results of the wargaming analysis.

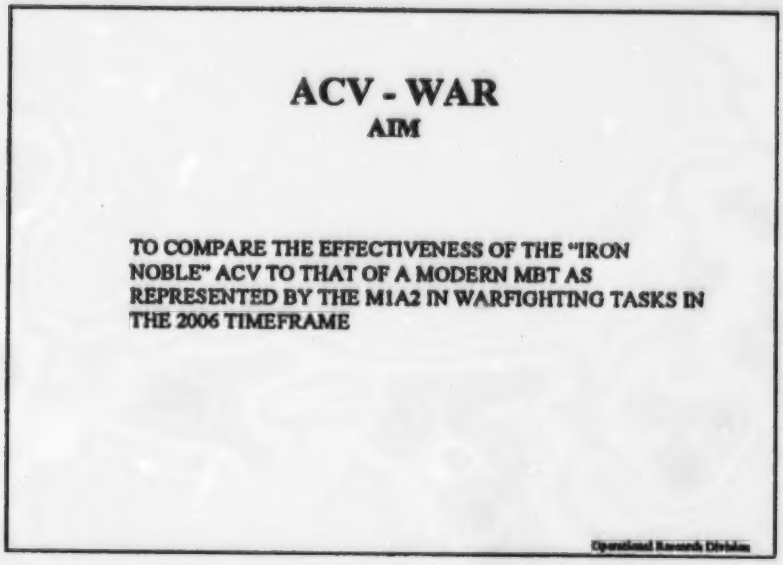


With the armoured combat vehicle project the Canadian Land Forces intends to replace the cougar vehicle with a new armoured fighting vehicle that is optimized to perform effectively in operations other than war. Introduction date for the vehicle is planned for the year 2005.

The definition phase of the project identified fifteen common tasks that an armoured combat vehicle might have to perform by considering all the OOTW missions of the Canadian Forces. A statement of requirement was then defined by summarizing the capabilities required to complete these fifteen tasks. This identified the need for a light armoured vehicle with a 105mm gun.

The war gaming study dubbed "IRON NOBLE" compared the effectiveness of this conceptual ACV to the cougar in operations other than war. Six of the fifteen tasks were deemed suitable for wargaming and were gamed in three terrains.

The final results of "iron noble" show that, given each task on each terrain is equally likely, the ACV equipped force suffers half the casualties and kills twice the number of enemy compared to a cougar force

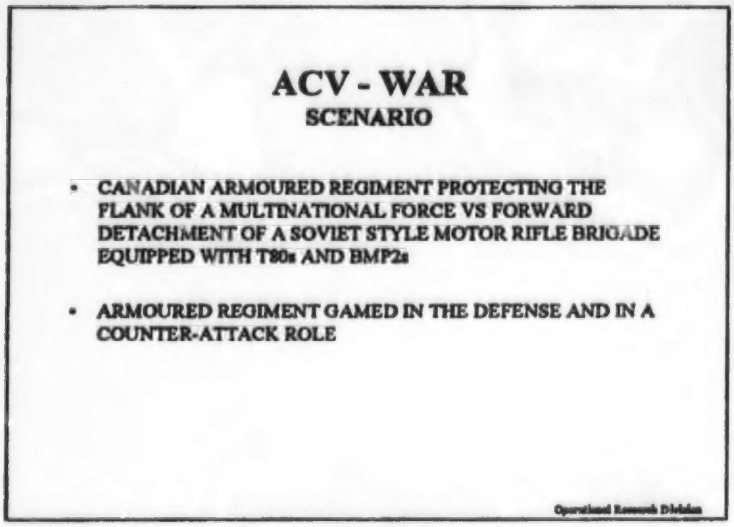


In 1992 approval was granted for a two tiered approach for providing direct fire support. Within the low and medium levels of conflict the Cougar is being replaced with the ACV.

Within medium and high levels of conflict, heavy armour is deemed to be required; the leopard c1 main battle tank which is to meet this requirement is to be upgraded in the near-term and replaced around the year 2010.

However, in 1996, the land forces army 2000 campaign plan stated that the Leopard will be replaced with a light armoured vehicle armed with a 105mm gun and be employed across the spectrum of conflict.

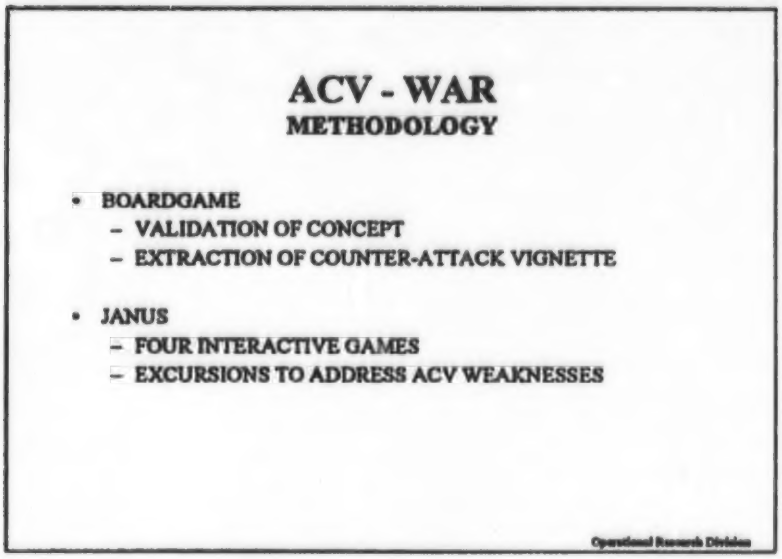
Hence the aim of this wargame series is to compare the effectiveness of the iron noble ACV to that of a modern main battle tank, as represented by the M1a2, in warfighting tasks in the 2006 timeframe.



The two distinct warfighting tasks that can be assigned to an armoured regiment are to attack and to defend. So as to reduce the development time, a general scenario was selected which encompasses both tasks. From this larger scenario two vignettes were identified and gamed. The general scenario helps to keep these smaller scenarios in perspective by providing a realistic environment within which the vignettes take place.

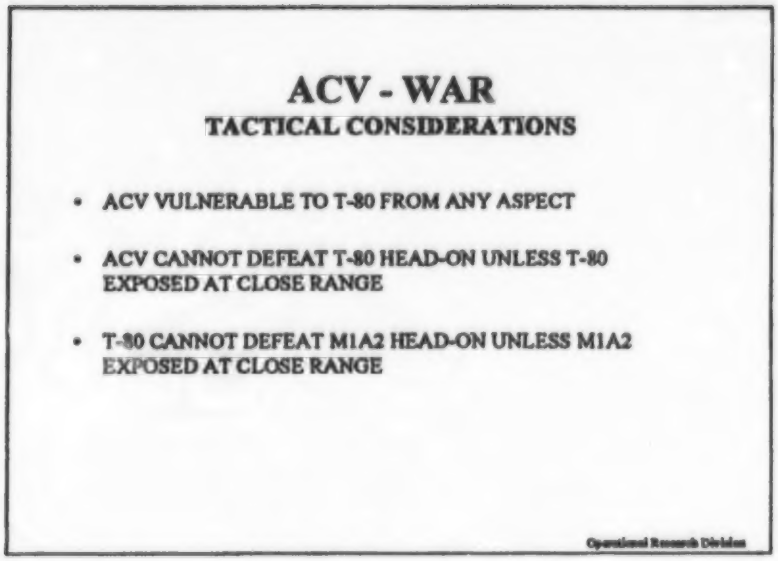
The general scenario consists of a blue multi-national, two-brigade division advancing along an axis with a Canadian armoured regiment acting as its flank guard. The red force is aware of the advancing blue force and is manoeuvring an independent motor rifle brigade to attack the flank of the blue force with the mission of disrupting blue's advance.

For the defence vignette, at some point in the general scenario a blue battle position is confronted by the forward detachment of the red IMRB. Blue conducts a hasty defence and initiates a delaying action. As for the attack vignette the commander of the blue flank guard has decided, in concert with the defend vignette, to make a hasty attack against the depth element of the forward detachment. Key systems for blue include the ACV with a 105mm gun or M1a2, APCS and ADATS, the red force key systems include the T-80U and BMP-2s with era and at-14 missiles.

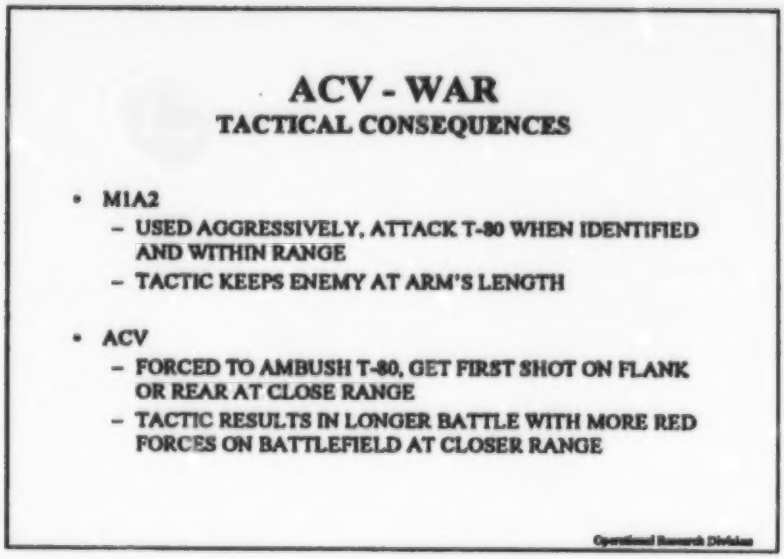


The approach taken for the conduct of the study was to begin by boardgaming the interaction of the blue flank guard with the red forward detachment as an open two-sided game to familiarize the players with the vignettes and to confirm the vignettes for JANUS.

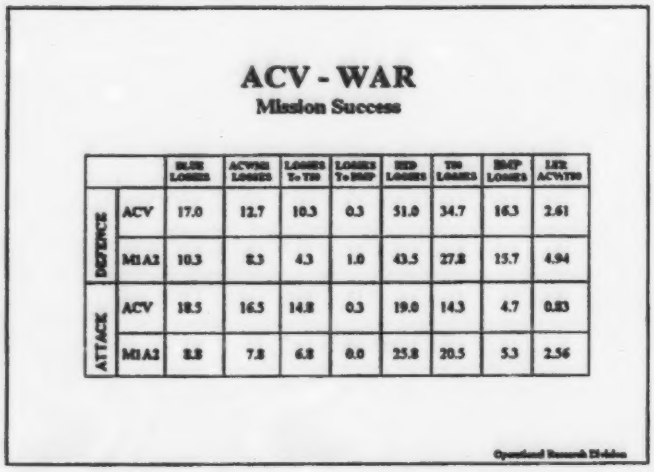
Each of the vignettes was then played interactively four times in JANUS with the ACV and then substituting the ACV for the M1. Excursions were also made to examine the effects of improvements to the ACV .



Before presenting the detailed results let us focus on some tactical considerations and their implications or consequences for the blue commander's conduct of the wargame. This by far resulted in the most noticeable difference between the games. First, it should be noted that the ACV is vulnerable to the T-80 from any aspect, second, the ACV cannot defeat the T-80 head-on unless the T-80 is exposed and at close range and third, in a similar fashion the T-80 cannot defeat the M1 head-on unless the M1 is exposed and at close range.



The tactical consequences of these observations for the blue commander are presented here. In games employing the M1 the blue commander used them aggressively to attack the T-80s as soon as they were identified and within range. When employing ACVs the blue commander attempted to ambush the T-80s to get first shot at close range against the flank or the rear of the T80. This resulted in longer battles than with the M1, with more red forces on the battlefield and at closer range.



		BLUE LOSSES	ACV/M1 LOSSES	LOSSES To T80	LOSSES To BMP	RED LOSSES	T80 LOSSES	BMP LOSSES	LER ACV/T80
DEFENCE	ACV	17.0	12.7	10.3	0.3	51.0	34.7	16.3	2.61
	M1A2	10.3	8.3	4.3	1.0	43.5	27.8	15.7	4.94
ATTACK	ACV	18.5	16.5	14.8	0.3	19.0	14.3	4.7	0.83
	M1A2	8.8	7.8	6.8	0.0	25.8	20.5	5.3	2.56

Turning now to the results this next slide shows the overall results of the ACV and M1 forces in both the defence and attack scenarios. These results reflect the averages over the four JANUS runs. It summarizes the losses on both sides with particular emphasis on ACV/M1 losses. The first column labelled blue losses reflects losses of key blue systems that include the ACV or M1 as well as the APCS and ADATS. The second column reflects the total ACV and M1 losses from all sources. These are then broken down into ACV/M1 direct fire losses to the T80 and BMP respectively in the next two columns. The red losses column shows the total T80 and BMP losses and these are then split into the next two columns.

A few points to note here, to begin with let us consider blue losses. We can see that they are higher for the ACV than for the M1 and in particular they are more than double against the T-80 threat. On the red side we note that in the defence the ACV force achieves more kills than the M1; 51 total red losses to 43.5 - this is as a result of the tactic being employed. As indicated earlier - with the ACVs ambushing the T80s the game ends up in a situation where there are more forces in play at closer range with units being decisively engaged. This leads to heavy losses on both sides.

With respect to the BMP it can be seen that under each vignette the ACV and the M1 achieve comparable number of kills and that the BMP kills of ACV and M1 are relatively small. It is no surprise to see that the T80 is the major threat to the blue forces on the battlefield.

The last column in the table reflects the loss exchange ratio between the ACV/M1 and the T80. That is the ratio of the T80 losses to ACV/M1 losses. We see that the M1 loss exchange ratio is twice that of the ACV in the defence and three times in the attack. We should also take note of the fact that in the attack the ACV ler is less than one.

ACV - WAR

ACV/M1 Lethality: Gun Effectiveness vs T80

		OVERALL	HEAD ON			FLANK		
		LETHALITY	% SHOTS	LETHALITY	RANGE (KM)	% SHOTS	LETHALITY	RANGE (KM)
DEFENCE	ACV	0.44	19	0.42	1.14	81	0.44	1.60
	M1A2	0.49	47	0.43	1.87	53	0.56	1.88
ATTACK	ACV	0.48	14	0.43	0.80	86	0.48	1.40
	M1A2	0.47	54	0.41	1.48	46	0.55	1.61

Let's examine in a little more detail the underlying results with respect to the ACV/M1 lethality against and vulnerability to the T80. This slide shows overall ACV/M1 lethality against the T80 in each vignette along with a breakdown of the information by target aspect as either head-on or flank. Even though the M1 has a distinct firepower advantage over the ACV it is not immediately reflected in the overall lethality rates from these games. The overall lethality's for the ACV and M1 are comparable. Now why is that? If we focus our attention on the engagements against the flank of the T80, we see that the M1 has a greater lethality and achieves it at a longer range. We can also see that head-on lethality rates for the ACV and M1 are comparable but with a much greater range advantage to the M1. What renders the overall lethality rates to comparable values is the distribution of engagements by aspect. We can see that more than 80% of the ACV engagements are against the flank of the T80. Even more, although not shown in the table here, most of the ACV shots against the front of the T80 are against an exposed T80 and at much closer range than flank engagements.

ACV - WAR

ACV/M1 Lethality: T80 Kills

		LETHALITY	SHOTS	KILLS	RANGE (000)
DEFENCE	ACV	0.44	61.7	27.0	1.51
	M1A2	0.49	42.5	21.0	1.88
ATTACK	ACV	0.48	25.8	12.3	1.32
	M1A2	0.47	36.5	17.3	1.54

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This slide shows the resulting ACV/M1 lethality in terms of T80 losses. In the defence the ACV achieves a greater number of T80 kills compared to the M1 as a result of the tactic employed with ACVs. The ambush results in both sides being decisively engaged with much more forces in play. With the M1 the Blue Commander was able to inflict heavy losses on red much earlier in the battle leading to the red commander's decision to breakoff the engagement much earlier. In the attack vignette the red forces are now dug in and the ACV force is not in a position to ambush the enemy. Consequently, ACV losses build up with time reducing blue's firepower. In this case the M1's superior armour protection allows it to survive on the battlefield longer resulting in a larger number of M1 engagements against the T80 and hence a larger number of T80 kills than the ACV.

ACV - WAR

ACV/M1 Survivability: T80 Effectiveness

		OVERALL	EXPOSED			DEFILADE		
		SURVIVABILITY	% SHOTS	SURVIV.	RANGE (KM)	% SHOTS	SURVIV.	RANGE (KM)
DEFENCE	ACV	0.66	9	0.25	2.23	91	0.70	1.76
	M1A2	0.75	87	0.73	2.83	13	0.89	2.02
ATTACK	ACV	0.58	21	0.40	1.73	79	0.63	1.37
	M1A2	0.60	33	0.55	2.26	67	0.62	1.84

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Turning our attention now to ACV/M1 survivability this slide shows the overall survivability to the T80 in each vignette along with a breakdown of the information this time into ACV/M1 status of exposed or defilade. Here again even though the M1 has superior armour protection to the ACV it is not immediately reflected in the overall survivability rates from these games. The overall survivabilities for the ACV and M1 are closer than one would expect. The data shows why the Blue Commander did not want to expose the ACVs to enemy fire. When exposed the ACV survivability is well below its defilade survivability. The difference in blue's tactics, particularly in the defence, is also evident here as only 9% of the T80 engagements are against an exposed ACV as compared to 87% for engagements against the M1.

ACV - WAR

ACV/M1 Survivability: Losses

		SURVIVABILITY	SHOTS	LOSSES	RANGE (KM)
DEFENCE	ACV	0.66	30.7	10.3	1.80
	M1A2	0.75	17.3	4.3	2.73
ATTACK	ACV	0.58	35.5	14.8	1.45
	M1A2	0.60	16.8	6.8	1.98

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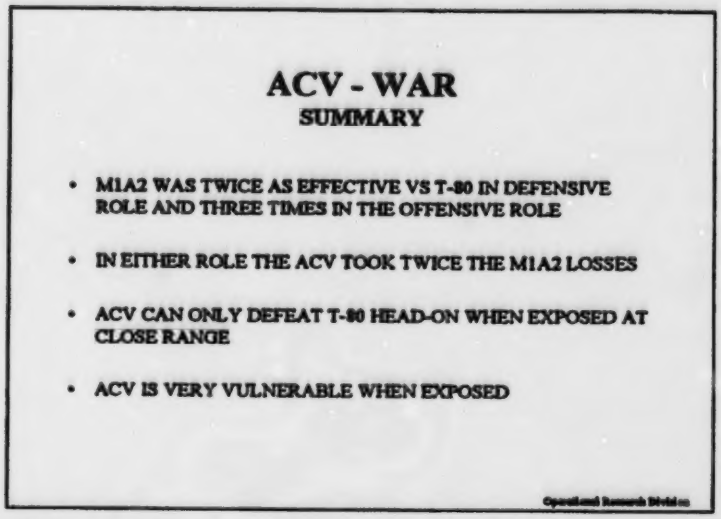
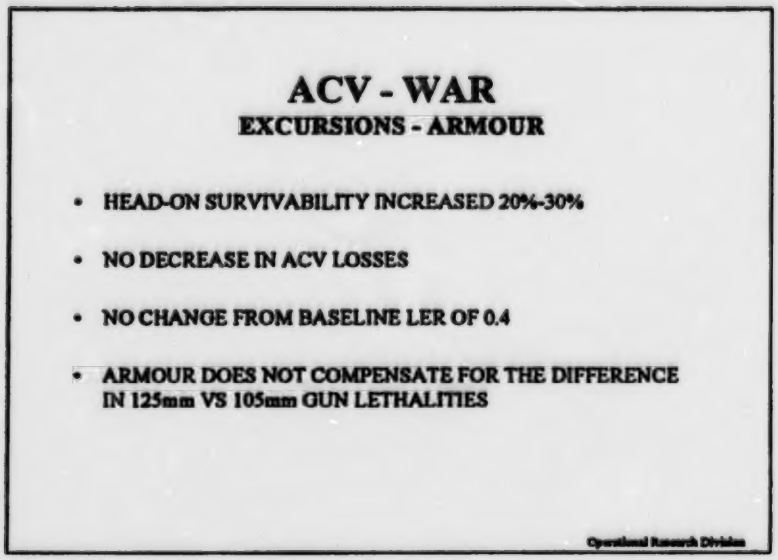
This slide shows the resulting ACV/M1 vulnerability in terms of losses. In both vignettes the ACV takes twice the number of shots that the M1 does resulting in much heavier losses of ACVs. In the defence the heavier ACV losses are a result of both the tactic being employed and the fact that the T80 can successfully engage the ACV from any aspect.

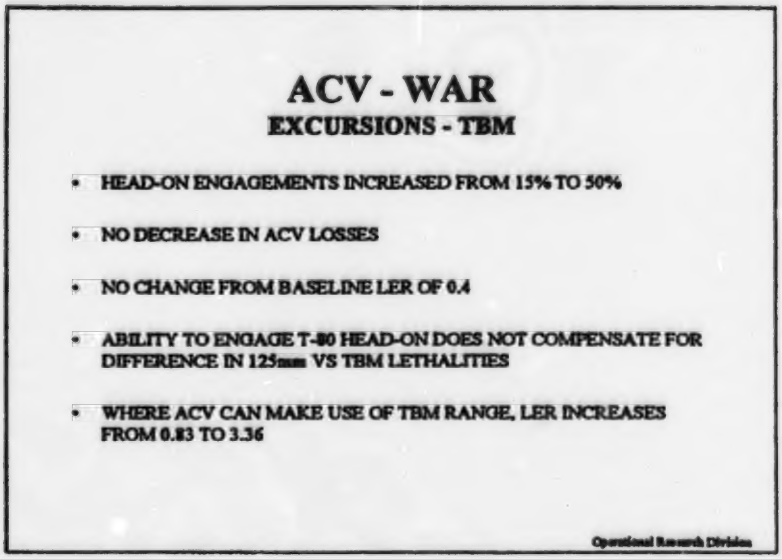


Summarizing the results to date in a few brief points we see that when comparing loss exchange ratios on the defence the M1 is twice as effective as the ACV against the T-80 and it is three times as effective in the attack. We have also seen that in both vignettes the ACV has taken twice the number of M1 losses. This next point concerning the lethality of the ACV had already been identified in the tactical considerations leading up to game play but was confirmed through the gaming results namely that the ACV can only defeat the T-80 head-on when the T-80 is exposed and at close range. The gaming results showed that the ACV is very vulnerable when exposed. And a final point not reflected on the slide here, as it did not come from the analysis but rather from the military gamers judgements and insights resulting from the gaming was that the ACV is more vulnerable to indirect fire.

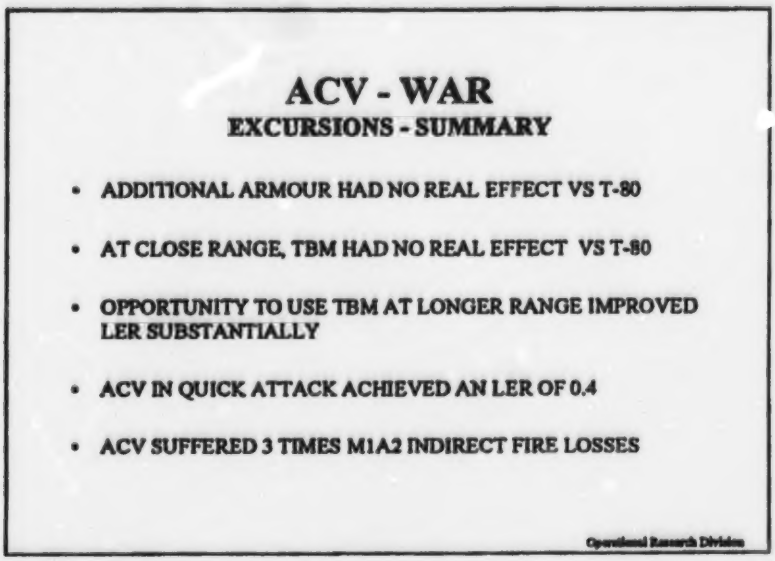
To address the ACV's weaknesses in lethality and survivability further gaming was conducted. For these excursions a very short quick attack vignette was established with a fixed red artillery fire plan. For these excursions the baseline ACV was compared with gaming results of an up-armoured ACV with 400 mm of additional frontal armour and then with an ACV equipped with a through the barrel missile capable of defeating the T-80 head-on. The results of these excursions are presented in point form on the next three slides.



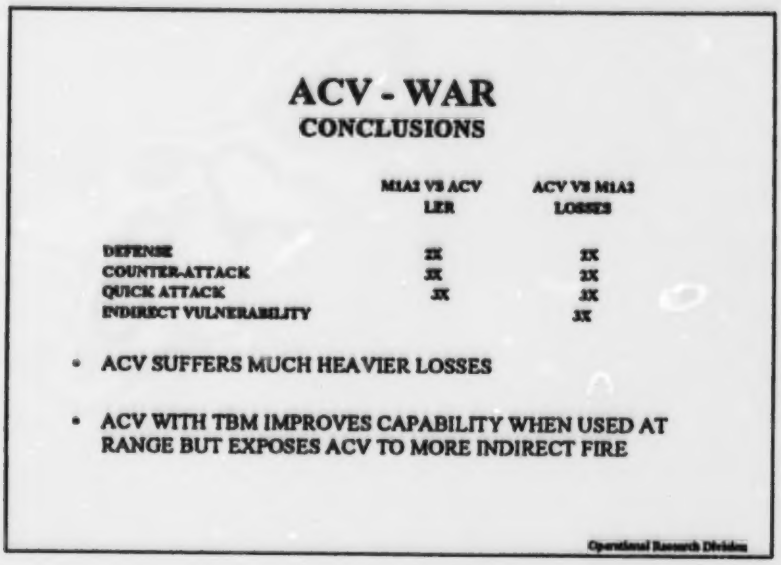
First the impact of additional armour on the ACV. The results indicate an improvement of 20 to 30 percent in head on survivability. However this did not lead to fewer ACV losses. The data showed that the up-armoured ACV did survive a little longer on the battlefield, but at the ranges involved, which are within a kilometre, the single shot kill probabilities show that the T-80 required but an additional shot to the ACVs three for a kill. It should also be noted that in the quick attack the loss exchange ratio is even lower at 0.4 than in our original vignette. In a quick attack the ACV achieved on average only 4 T-80 kills for every 10 ACV losses.



This slide summarizes the impact of an ACV with a through the barrel missile (TBM) capability. The results do indicate that the ACV was now able to engage the front of the T80 as head on engagements did increase from 15% to 50%. However, here again as a result of the proximity of the forces in play it did not result in any improvement on the battlefield. The TBM equipped ACV was then played in our original attack vignette where it could take advantage of the missile's range. In that instance we observed a marked improvement in the ACV results where the loss exchange ratio now increased fourfold from 0.83 to 3.36.



The excursions centered on the quick attack vignette, indicate that additional armour had no real effect on our effectiveness against the T80. At close range the TBM had no real effect against the T80, however given opportunities to employ the TBM at longer ranges resulted in a much improved loss exchange ratio. And a final point, in the quick attack vignettes the advantage of a fixed red artillery fire plan provided some data to assess the ACV/M1 vulnerability to indirect fire and it showed that the ACV suffered three times the M1 losses.



This last slide brings together the results from all vignettes including excursions. The first column shows the M1 advantage over the ACV in terms of ler and the second column reflects the increased losses for the ACV. It shows that in the defence the M1 has a ler that is twice that of the ACV with the ACV taking twice the losses. In both the attack and the quick attack the M1 has a three fold improvement in ler over the ACV with ACV losses being double that of the M1 in the counter-attack and triple in the quick attack. The excursions did indicate that the effectiveness of the ACV can be improved with the addition of a TBM capability when and where terrain permits its use, but it does expose the ACV to more indirect fire.

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ACV – Armoured Combat Vehicle
Cougar
MBT – Main Battle Tank
QUARRÉ DE FER
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